

IDRC Briefing



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The Mountain Sculptors

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The grandest of all human sculptures are, in fact, the work of the planet's poorest people. Unable to find a job or a plot of land in the valley, the most disadvantaged people of the developing world carve mountains to grow their food. Mountainside farming offers an extraordinary spectacle. A single slope can be covered with hundreds of terraces, themselves carved up into dozens of little parcels separated by walls made of earth or stone. Whether they take the form of flooded rice paddies mirroring the sky or successive green steps of wheat, these thousands of tiny plots climbing up the mountain fill the eye with admiration.

BY JEAN-MARC FLEURY

Farming goes mountain climbing

The problem with terraced mountainsides is that they hide a cruel irony. While many would agree that mountain farming is a visual success, there is much less accord about its viability. In fact, the record of mountain farming is one of repeated disaster. The soil of the marshlands that surround modern Italy once covered the mountains that are now denuded and eroded. Archeologists also attribute the catastrophic erosion of the mountains and hills of ancient Greece to successive waves of deforestation. Yet these same experts can point to remarkable examples of durability. In Greece, for example, the terraces that were built in Plato's time have withstood the ravages of erosion for more than two thousand years.

What will the archeologists of some future millennium have to say about the farmers who today cultivate the slopes of the Andes, the Himalayas and the mountains of Central Africa?

Today, two-thirds of the non-irrigated farmland in developing countries suffers from some degree of limitation on its productivity: acidity, aridity, salinity or erosion. Ten percent of this land, located on the flanks of mountains, is especially vulnerable to erosion.

In many of these lands, where on the average people can rely on plots of land measuring only 30 metres by 50 metres, the mountains are under a state of siege. Nepal is a good example of a country where the limited supply of farmland is under constant and increasing demographic pressure. With the highest mountains in the world, and one of the fastest-growing populations (2.6 percent), the Kingdom of Nepal represents a veritable lab-



oratory for studying the impact of farming on mountains. Few Alpine environments have been so thoroughly shaped by man as the middle ranges of Nepal, located between the peaks of the high Himalayas to the north and the Indian plain to the south.

Since 1989, a team from the International Centre for Integrated Mountain Development (ICIMOD), mainly funded by the Swiss Agency for Development and Cooperation and with support from IDRC, has been studying farming in the valley of the Jhikhu River, located some 40 kilometers to the east of Kathmandu. The Nepalese team also includes Swiss and Canadian scientists.

After 10 years of research, scientists examining this valley of 11,000 hectares, located at altitudes of between 750 and 2,100 meters above sea level and inhabited by more than 33,000 people, have painted a picture of a land that is on the brink of exhaustion. Experts are full of praise for the skill, the spirit of enterprise and the hard work of the inhabitants of Jhikhu Khola (khola means "river" in Nepalese). But they fear that the increasingly intense exploitation of every square metre of soil will be seen as folly by future generations of archeologists.

Up to four crops a year

Traditionally, the low walls that separate the fields have served as footpaths. Yet today it is wise to look carefully where one steps when walking along the walls between the terraces of Jhikhu Khola. In the dry season, for example, one is just as likely to crush a potato plant there as in the middle of the field.

Putting these walls to use is just one of the many signs of the intense farming fever that has seized the valley. Traditionally, irrigated terraces were used to grow rice in the rainy season, and then wheat and potatoes when the land dried out. On those terraces that depend exclusively on rain water, the traditional crops have been millet or corn. In the 1980s, it was



Poor farmers in the Himalayas forage for leaves in the forest, which they use as feed for their animals and as litter.

common to take only one annual harvest from a plot of land. Yet Bhuban Shrestha, a geographer with ICIMOD, and Sandra Brown from the University of British Columbia have found that the farmers of Jhikhu Khola now take two or three harvests every year. A growing proportion of families are planting as many as four crops in succession on their parcels of land.

"What this means," says Hans Schreier of the University of British Columbia, "is that the soil never has a chance to rest for more than three or four days between crops. You have rice, followed by wheat, followed by corn. And this goes on year in and year out. Crops are being harvested so frequently that we must ask ourselves: how long can we keep up this rhythm?"

In addition to cereals and tuber crops, we now find vegetables, spices and condiments that can be sold in the markets of the nearby capital city. The valley must now also meet a market demand for milk, which was once a product used solely for home consumption.

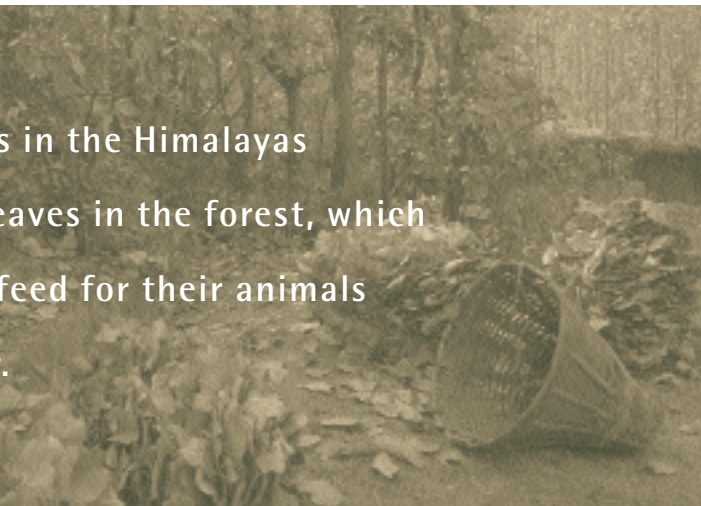
The tremendous energy and drive of the farmers of Jhikhu Khola, whose numbers are growing by 3.1 percent each year, is leading them to cultivate ever more inappropriate soils. Shrestha and Brown calculate that two-thirds of the lands that were cleared between 1972 and 1990 were on slopes with a gradient steeper than 20 percent. Even slopes of 36 to 49 percent that were once covered by trees and brush are now under cultivation. By way of comparison, the slope of a standard department store escalator is between 30 and 35 percent.

Trees feeding fields

In order to take as many as four harvests per year, the farmers of Nepal have to use sizeable quantities of fertilizer and organic material. "The management of organic material is the most critical factor. It is the single most

important element limiting soil productivity in the watersheds of Nepal," says P. B. Shah, a soil scientist and head of the Nepalese team.

Traditionally, farmers have relied on cow or buffalo manure, even if they had only one cow or one buffalo, as an organic additive. But, of course, in order to obtain manure one first has to feed the animals.



Poor farmers in the Himalayas forage for leaves in the forest, which they use as feed for their animals and as litter. Whether they have passed through the four compartments of the ruminant stomach, or whether they have simply been used to soak up excretions, the leaves end up in the fields where they supply indispensable organic matter. "The Nepalese rely on the forest for 95 percent of the leaves they use," says Schreier. "Every day they need two or three huge bundles. In some forests, during the dry season there is nothing left under the trees. The forest is so clean that there are no forest fires because there is nothing left on the ground to burn."

Having been stripped of its cover of leaf nutrients, the forest soil is impoverished. In fact, forest soils are poor to start with. "And since what can be collected in the forest is not enough to meet the demands of intensive agriculture, it's like burning the candle at both ends," adds Schreier.

The demand for wood for cooking fuel, for construction and for baking bricks adds to the pressure on the forest. Shrestha adds a note of caution to optimistic reports that the forest cover of Nepal has increased since the 1980s. From the air, all looks well. But, down in the forest, there are fewer

trees. The canopy looks healthy from above because the diameter of the remaining trees is bigger. "But we no longer find any young trees," he says, "because the demand for wood is so great."

Drought in the mountains

Most of the valleys of Nepal receive abundant rainfall; the monsoon brings between 1.8 and 3.2 metres of water every year to Jhikhu Khola. Yet Juerg Merz, a Swiss hydrologist, has found that terraces in the higher part of the valley are already suffering from a shortage of water, while those at lower levels will soon face the same threat.

The extraordinary system of traditional irrigation is a marvel of engineering. From the headwaters of the valley, water is fed into the channels from each side of the river. The channels run parallel to the river on its course down into the valley, but their slope is much more gentle, and their relative height above the riverbed becomes greater as it descends. In this way Nepalese farmers have for centuries been able to bring water to the slopes of their mountains without benefit of pumps.

Yet this water supply is no longer enough to sustain today's vegetable crops during the dry season. In the space of a few years, the number of motorized pumps has multiplied. In the 1998-1999 season alone, at least a hundred pumps were installed.

Lack of manpower

The relentless exploitation of the land has forced farmers to change their habits. In some cases, the effect has been beneficial. For example, since they no longer have time to go into the forest for leaves, farmers are now planting trees around their homes. On the other hand, they also have less time to maintain their irrigation ditches and terraces, and this extremely complex infrastructure is now threatened with deterioration.

For their part, the women, even more than the men, are being made to feel the negative impact of intensified agriculture. Milk production, in particular, means more work for women.

Scientists have noted that women's priorities are very different from those of men. When men and women were asked separately what use they would make of additional income, the men opted for buying more buffalo cows (to increase their milk production), while the women would put it into jewelry. When women were asked why they would not buy buffalo, they answered: "Who will look after the animals? Who will feed them? Who will milk them? We will. We already have enough to do, and we don't need any more work."

On the other hand, it is not just for vanity's sake that women would like to buy jewelry. It is the only way to have a quick source of cash on hand when some member of the family falls sick.

Shrestha has calculated that the net average income that a family derives from milk production is only 1,225 Nepalese rupees, or US\$18.

Despite these slim earnings and the growing work burden, he notes, people are still eager to produce milk.

The soil is degrading

P. B. Shah and his team have found evidence of a dramatic and disturbing change in the farming soils of the valley. Their studies show that the degree of soil acidity is reaching a dangerous level where metals such as aluminum are released. Aluminum is a real poison for crops. Moreover, soil that has been poisoned by aluminum is very costly to rehabilitate. Shah blames this increased acidity on the nature of the soils themselves and on the use of inappropriate fertilizers such as ammonia sulfate and urea.

Moreover, scientists have now shown that the use of pine needles can contribute to acidity in the soil. They are happy to see reforestation efforts, but they are critical of the practice of using pines as the only species in replanting. The Nepalese government is being strongly urged to promote the planting of native deciduous species, which produce leaves that animals can eat and which, in this way, will help to increase the nitrogen content of the soil.

Nepalese farmers do not perceive the impacts of the process of acidification. Thus they unknowingly contribute to it because they cannot obtain proper fertilizers, they are surrounded by pine plantations, and there is no effective public service available for soil analysis. Yet it is difficult to blame the farmers for a phenomenon that can only be measured in the laboratory.

Robbing the poor to benefit the rich

Because of the deforestation of the Himalayas, Nepalese farmers are widely thought to be responsible for the disastrous flooding and sedimentation that afflict the rivers of Bangladesh and India. Yet the reality is more complex.

Young mountains like the Himalayas are still growing, by as much as 10 millimetres per year. At the same time, they are being eroded at a rate of one millimetre per year. In geological terms, growth and erosion go together. These phenomena together give rise to forces that are out of all proportion to human activities.

Initially, scientists believed that the soil carried away by the rains was lost forever. Yet the terraces are arranged in such a way that the soil washed from one terrace will be captured by the next. Unfortunately, it is generally

Key Fact

- Slopes that have been denuded and degraded will lose 25 to 40 tons of soil each year. Soils with a cover of plants and the occasional tree will lose less than 5 tons per year. Terraced fields on mountain slopes lose from 3 to 15 tons, depending on the texture of the soil, the rainfall pattern, and the crop cycle.

the poorest farmers who cultivate the highest terraces, and soil lost to them is soil gained for the richer farmers in the lower reaches of the valley.

Scientists have also had to rethink their notions about the causes of erosion. "From 75 to 80 percent of the rainfall comes in July and August. I had always thought," admits Shrestha, "that these heavy rains were responsible for most of the erosion. And yet I was completely wrong. In fact, 80 percent of all erosion happens before – not during – the monsoon. The reason for this is that the vegetation cover expands incredibly fast as soon as the monsoon begins. And as soon as plants cover the soil, they will hold it in place and prevent erosion."

The ICIMOD team has shown that anywhere from 40 to 90 percent of erosion can be caused by just two pre-monsoon storms. A single pre-monsoon storm was shown to have dumped 500 millimetres of rain in 24 hours. "That will cause thousands of landslides. And there is nothing we can do about it," says Shrestha. "We have now identified five or six of these events over the course of the last 20 years."

There is little that scientists can do about these events, which are less exceptional than was once thought.

This does not by any means prove that it is sediment from the terraces of Nepal that is silting up the riverbeds of the Ganges and the Brahmaputra. Farmers build dozens of weirs and dams to retain the soil that is washed away from their terraces. They then recover that soil and spread it again on their fields. Even sediments that eventually find their way down the valley and into the river do not necessarily end up in Bangladesh. "It will probably take millions of years before the soil that is washed from the terraces of the Nepal will get that far," says Schreier.

Nonetheless, scientists are concerned about the welfare of farmers in the middle mountains of Nepal. They are in no doubt as to the consequences of the intensive farming needed to ensure food security, the pumping of water, the shortage of organic material, contamination by pesticides, soil acidification and erosion — all of these pose a threat to the viability of farming systems in valleys like the Jhikhu Khola.

What Is IDRC Doing?

As explained by John Graham, the program officer who is based in Singapore, a detailed study of the Jhikhu Khola Valley was undertaken by ICIMOD, with financing from the Swiss Agency for Development and Cooperation and from IDRC, with the aim of bringing about a long-term improvement in management of the entire basin, one that will rebound to the benefit of its inhabitants. Based on the results of this study, scientists have begun to test potential solutions in close cooperation with the community. Since what is happening to Jhikhu Khola can no doubt be taken as a portent for many other valleys in the Himalayas, ICIMOD intends to ensure that the new techniques and policies applied in Nepal are publicized throughout the region.

How can a valley's overall ecosystem and the welfare of its inhabitants be enhanced? This is the challenge that IDRC is helping scientists to address. Initially, the Centre agreed to finance research into improving specific plants. The scope of research proposals has subsequently been broadened progressively to cover all production systems, including plants, trees and livestock, and finally the whole area of farm operations.

In the future, the focus will shift to some extent from the individual farm to the community level. For IDRC, it is not enough to show farmers better ways to manage their own resources. The community as a whole must be helped to undertake long-term management of its common resources: water, forests, infrastructure and landscapes.

As part of the research work at Jhikhu Khola, the team of scientists has produced a detailed map of the valley that, among other things, highlights areas that are particularly susceptible to erosion. Indigenous shrubs have also been identified that can enrich the soil and produce the kind of leaves foliage that animals will eat. These species have been made available to farmers, who have already begun to plant them.

In order to reduce the demand for water, scientists have tested the use of a mulch cover to conserve soil humidity, and the introduction of drip systems that will avoid wasting water. Under the direction of Gopal Nakarmi, a hydrologist, a 10 cubic meter concrete demonstration cistern has been built. This cistern is fed from a catchment area of 1,500 square meters. It cost 24,000 rupees (US\$352), a considerable sum, but no more than a successful pepper grower can recoup in two years, according to Nakarmi.

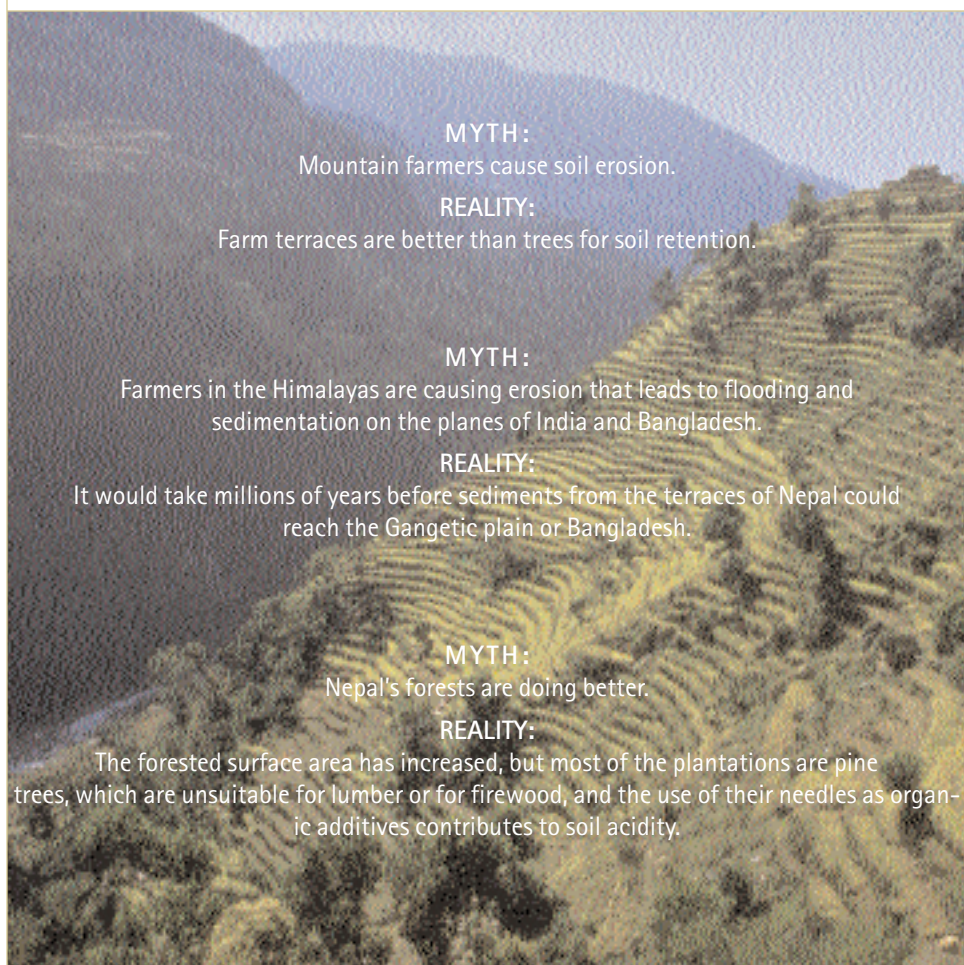
The steady growth in truck gardening has led to an explosion in the use of pesticides. In collaboration with the University of Tribhuvan in Kathmandu, farmers are being taught how to make and use biological insecticides.

To prevent erosion from the storms that precede or usher in the monsoon, drought-resistant plants have been identified. These plants will prevent the soil from becoming completely denuded during the dry season and will protect it from the first storms of the monsoon.

At the political level, the scientists are making great efforts to persuade forestry officials to use native species in reforestation work. The ideal would be to allow the existing pine plantations to be cut and replaced, but specialists have identified certain forage trees that can grow even under the cover of tall conifers.

According to Ronnie Vernooy, program officer for IDRC in Ottawa, the project is proceeding well. But there needs to be even closer involvement by the immediate users, both of individual farm resources and of the common resources such as the forest, water and landscape, the exploitation of which must be equitably shared. "That's where the real challenges lie," says Vernooy, "in the Himalayas and in other terraced mountain regions."

Myth and Reality



MYTH:

Mountain farmers cause soil erosion.

REALITY:

Farm terraces are better than trees for soil retention.

MYTH:

Farmers in the Himalayas are causing erosion that leads to flooding and sedimentation on the plains of India and Bangladesh.

REALITY:

It would take millions of years before sediments from the terraces of Nepal could reach the Gangetic plain or Bangladesh.

MYTH:

Nepal's forests are doing better.

REALITY:

The forested surface area has increased, but most of the plantations are pine trees, which are unsuitable for lumber or for firewood, and the use of their needles as organic additives contributes to soil acidity.

Resources

Websites

Virtual visit to the Jhikhu Khola valley
Institute for Resources and Environment,
University of British Columbia
www.ire.ubc.ca/related/nepal.htm

International Centre for Integrated Mountain
Development (ICIMOD)
www.icimod.org.sg/

Institute of Geography, University of Berne
www.giub.unibe.ch

Mountain Forum, a meeting place for research
on the world's mountainous regions
www.mtnforum.org/

CD-ROMs

Challenges in Mountain Resource Management
in Nepal: Processes, Trends, and Dynamics in
Middle Mountain Watersheds,
by H. Schreier and Sandra Brown,
Institute for Resources and Environment,
University of British Columbia, 1999

Gender and Resources in the Middle Mountains
of Nepal,
a CD-ROM by Sandra Brown
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University of British Columbia, 1999

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Himalayas – Complex problems – complex
options: Preservation, degradation and
rehabilitation in a Nepalese watershed,
Institute for Resources and Environment,
University of British Columbia, 1999

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Soil Fertility Issues in the Hindu Kush-Himalayas,
special issue of the ICIMOD newsletter,
winter 1998, ICIMOD, 28 pages.

Available on the ICIMOD website: www.icimod.org.sg/

Challenges in Mountain Resource Management
in Nepal: Processes, Trends, and Dynamics in
Middle Mountain Watersheds.

Proceedings of a workshop held at Kathmandu
in April 1995, ICIMOD/CRDI, 1995, 263 pages

Essential Information

What Is IDRC?

IDRC works with researchers in developing countries to help them find practical, long-term solutions to the social, economic and environmental problems facing them. In particular, support is directed towards developing the local research capacity necessary to sustain policies and technologies that will build healthier, more equitable, more prosperous societies.

The International Development Research Centre was established in 1970 by an Act of the Parliament of Canada.

IDRC Briefings

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